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Work Sampling and Methods Improvements in Shipment Preparation

Michael P. McCann
University of Central Florida

WORK SAMPLING AND METHODS IMPROVEMENTS IN SHIPMENT PREPARATION

BY

MICHAEL P. MC CANN
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WORK SAMPLING AND METHODS IMPROVEMENTS
IN SHIPMENT PREPARATION

ABSTRACT

A study was undertaken in the Shipping Center of Rohm and Haas Chemical Company in Philadelphia, Pennsylvania to determine what course of action should be taken to reduce overall costs in a labor oriented shipment preparation operation. This activity, which currently utilizes a complement of twenty-seven people, involves the preshipment labelling and stencilling of product and customer information to metal drums and pails plus various other preparation requirements. A work sampling was performed to determine manpower requirements by work category and this information was used to direct the methods improvements study into the most lucrative areas. By transferring the responsibility of label and stencil preparation from the Shipment Preparers, who work on the Shipping platforms, to Shipping Office personnel, and by changing stencil cutting and label storage methods, a net reduction of five people is projected.

Approved: C S Bauer
Dr. C. S. Bauer

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I. INTRODUCTION

This report demonstrates the methodology behind a cost reduction study in an industrial environment using work sampling technique.

For some time, the need for a comprehensive work methods improvements study in the preparation of finished goods at the Shipping Center of Rohm and Haas Chemical Company in Philadelphia, Pennsylvania has been apparent. With complements of twenty-seven men operating within an unskilled, labor oriented work system and with relatively low manpower utilization, the opportunity for methods redesign and improvement with consequent labor savings is very real. For this reason, a work sampling of Preparer activities was undertaken to obtain information so that the energy of the improvements study would be directed to those areas indicating the most attractive returns.

This report explains the results of the work sampling and the rationale behind the proposed choice of alternatives to existing Preparer work methods. The revised system entails substantial labor savings and will also set the stage for further improvements in Preparer utilization and shipping operations because of reduced manpower complements and work redistribution.

II. PRESENT SYSTEM

Each morning, approximately 200 orders are received at the Shipping Center by Teletype from the Home Office. These orders are printed with product code, shipping container, quantity, warehouse storage location, customer name and address, shipment routing, requested shipment date, and special labelling instructions. A majority of these orders contain one line item.

After receipt, four copies of the order are made. Two of these copies are routed within the Shipping Office for routine update of records and eventual filing. The remaining two copies are sent to the Shipping Order Scheduler who files the order by requested shipment date. Trucks are then scheduled into the Center, normally on one day's notification.

Prior to truck arrival, the Shipping Order Scheduler consults a master label reference book set up in product code sequence to determine label requirements for the product ordered. These labels are of several types. Some contain product identification and instructional information. Others have to do with hazardous material warnings as required by the Department of Transportation.

After entering the required label numbers on the order, one copy is sent via Dock Foreman to a Forklift Operator while the other copy is sent to the Shipment Preparer working the area where the order will be staged. The Preparer then goes to the label storage cabinet in his dock zone to retrieve required labels while the order is being picked in the warehouse.

During and after delivery of stock at the shipping dock, the Preparer is responsible for one or more of the following:

1. If the order involves steel drums that are rusted, corroded or visibly scarred, a refurbishing task must be performed. This normally involves scraping and repainting with a brush.
2. If the product label pulled doesn't fully describe the product grade, i.e., the label is of the fill-in type, a stencil must be cut so that the proper suffix can be applied to the label.
3. Customer requested codes and addresses must be stencil cut as specified on the order.
4. All labels and stencils must be applied to the shipping containers. Labels are applied with brush and glue.
5. In some cases, palletization of containers is required and assistance to the Forklift Operators in loading trucks is sometimes necessary.

6. Normal cleanup of preparation areas is done periodically.

The present system is flow charted in FIGURES 1, 2 and 3.

FIGURE 1. Shipping Office Work Flow

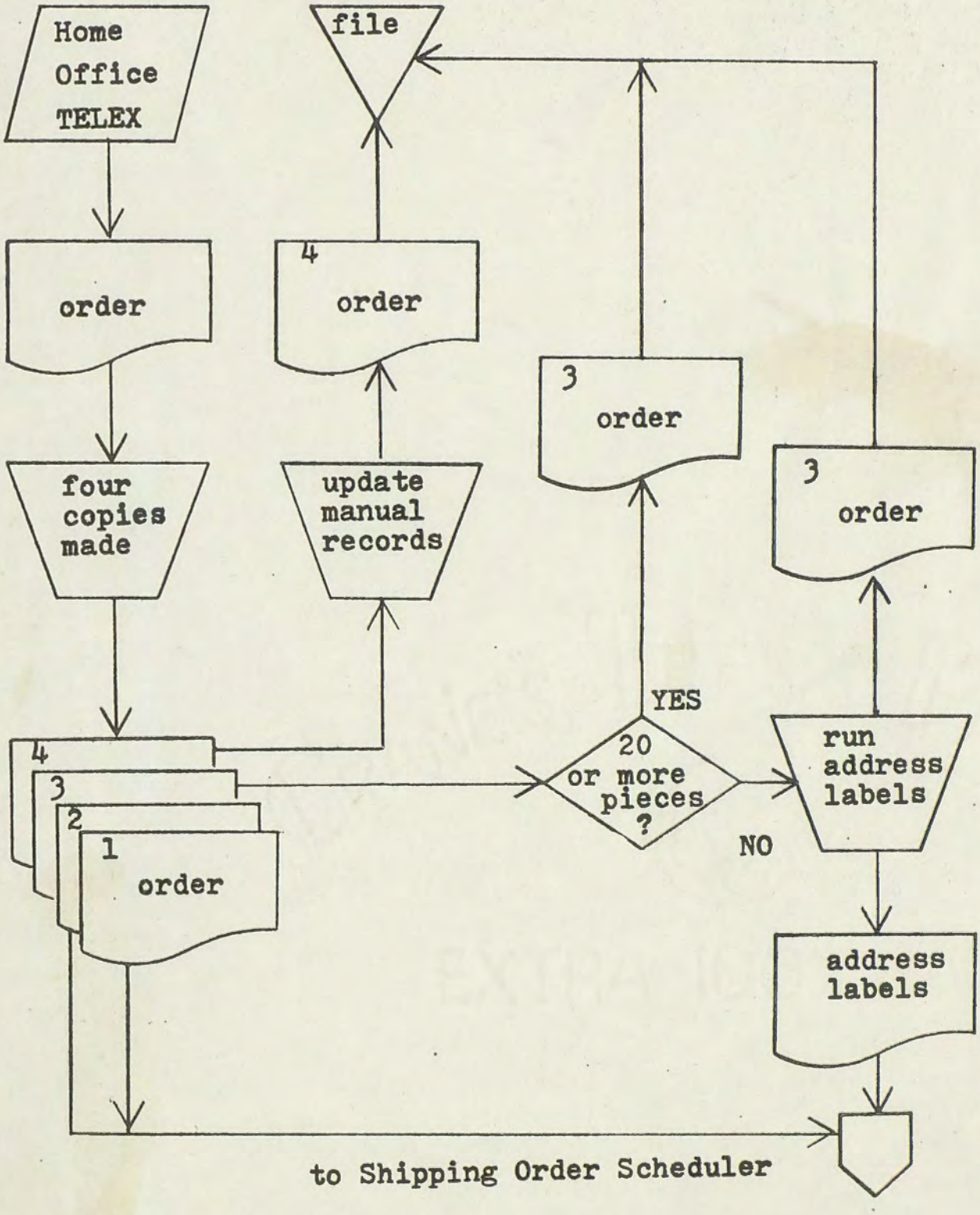


FIGURE 2. Shipping Order Scheduler
Work Flow

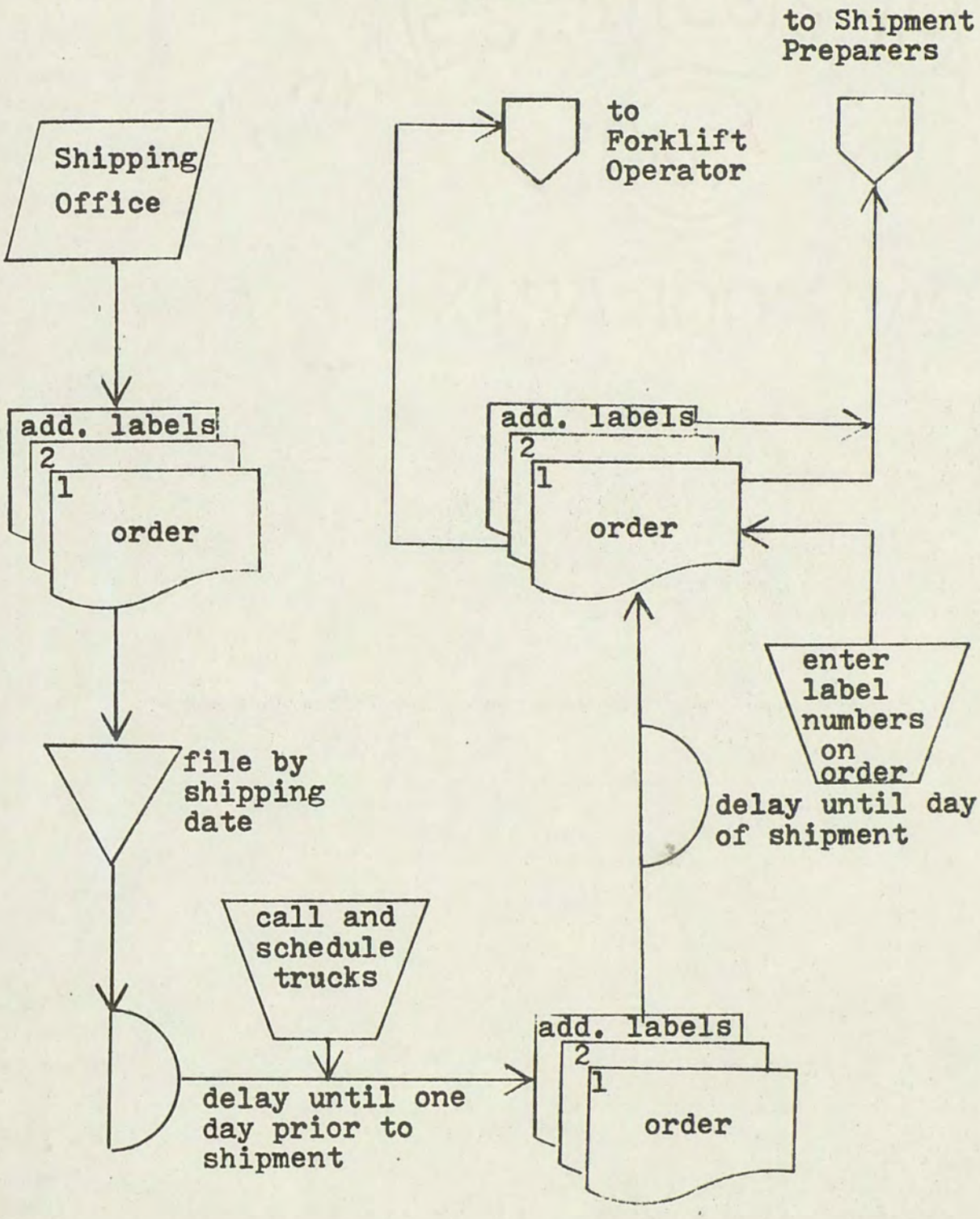
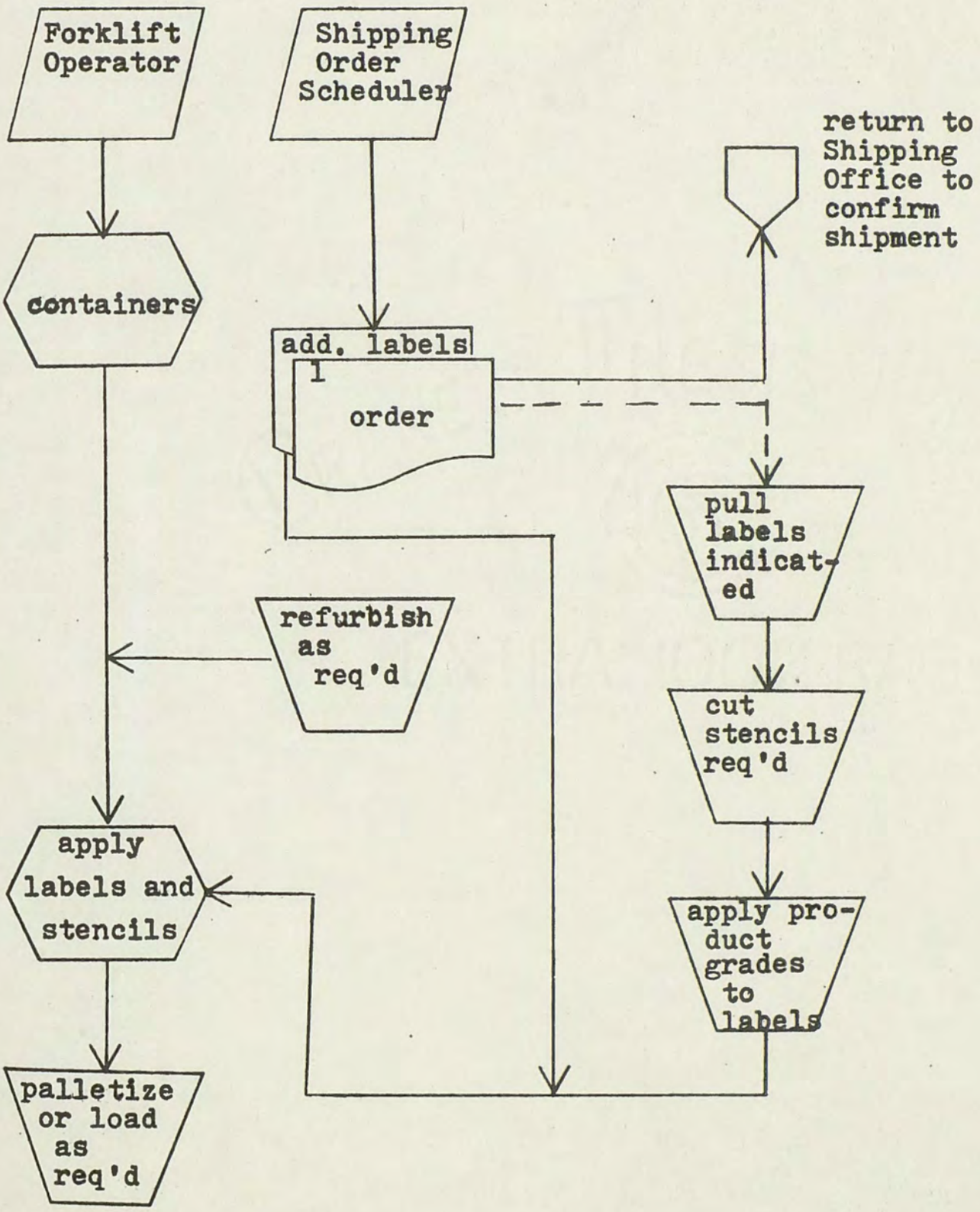


FIGURE 3. Preparer Work Flow



III. WORK SAMPLING RESULTS

The work sampling of Preparer activities was performed in the manner and under the conditions described in Appendix A. The sampling was terminated at the end of the nineteenth day after 1314 productive Preparer observations when it was felt that the accuracy level attained was sufficient for the purposes of the study.

Specific relative accuracies within a 95 percent confidence interval were calculated as (Barnes, 1968)

$$S = 2\,(1-p)^{\frac{1}{2}} / (Np)^{\frac{1}{2}}$$

where

S= the relative accuracy

p= percentage occurance

N= total number of observations

The results of this sampling are shown in TABLE 1.

An analysis of variance was performed by using daily control charts to identify any significant variations in category percentages. While there were certain days that these percentages showed appreciable deviation (more than could be attributed solely to sampling error), no identifiable extraneous effect could be found. It is assumed that these variations arose only from the incidental variation in the order requirements of the day. Daily

TABLE 1. Work Sampling Results[1]

	Category	Percent Occurrence	Accuracy Range (Percent)	Equivalent Manpower Allocation[2] (Conservative Value)
1.	Set-up - order review, label retrieval, stencil cutting, stencilling fill-in product labels	23	21-25	5.25 men
2.	Application of labels and stencils to containers	32	29-35	7.30 men
3.	Steel drum reconditioning[3]	16	13-19	3.25 men
4.	a) Loading freight	16	14-18	3.50 men
	b) Palletizing	2	1-3	.25 men
	c) Any other productive work	11	9-13	2.25 men

[1]Percentage ranges are based on a 95 percent confidence level with 1314 productive Preparer observations.

[2]Based on overall complement of twenty-seven less an average of two men engaged in activities away from the shipping platform and not covered in the sampling. Manpower allocations were taken at the lower end of the confidence intervals.

[3]The percent occurrence and range for this category as well as for categories 4(a) and 4(b), which were shift biased, was derived from a weighted average of the two shifts.

shipping volumes showed no effect on category percentages, apparently affecting only the utilization of manpower and not the production composition of the work day.

A comparison of the two shifts did show that the extent of the activities of categories 3, 4(a) and 4(b) changed from first to second shift, indicating some variation in the work composition of each shift.

In the third column of TABLE 1 is listed the equivalent manpower allocation for each activity category. This number is an important result of the work sampling in that it shows how many men out of the total complement are devoted to each of the activities listed. These numbers are based on a labor force of twenty-seven Preparers over two work shifts minus an average of two Preparers engaged in activities away from the normal prep zones and not covered in work sampling. Manpower equivalents shown in TABLE 1 are pessimistic or conservative values calculated using the percentage at the low end of the confidence interval. This is a precautionary measure aimed at minimizing the risk of over-projecting potential cost savings during analysis, and more important, of over-reducing manpower complements during implementation of the new system.

Finally, it should be noted that the equivalent manpower allocation value does not directly represent man-hours or man-days of work. This is because Preparer

utilization is less than 100 percent and it is assumed that the present staffing is required to cover peaks in shipping activities at the expense of incurring idle and waiting time under less active conditions. The contention is that the elimination of a certain percentage of the work will also eliminate the same percentage of the required idle or waiting time, and the combination of these two percentages is what the manpower equivalence represents. Manpower requirements would be further reduced if utilization could be increased by minimizing waiting times or if work paces could be increased.

IV. MANPOWER DEPLOYMENT AND UTILIZATION

Under current operations, each of the work shifts is assigned approximately the same number of Preparers. The work composition of each shift is also approximately equivalent with about the same amount of each category of work being done, with a few exceptions. In general, however, this is basically a distinct two-shift operation with loading increasing toward the end of each shift (see Appendix B.

Utilization was relatively constant over the course of the day with some drop at the beginning of the first shift and at the end of the second shift. First shift utilization was 68 percent with the second shift showing a slight increase to 73 percent. These numbers were calculated from recorded observation data showing 800 productive observations out of a total of 1176 and 514 productive observations out of a total of 704, respectively. However, as explained in Appendix A, these values are higher than the actual utilization because of the manner in which the sampling was performed. It can be concluded, however, that at least 30 percent of time, men were idle and this is attributed mainly to lack of available work.

As has been emphasized in previous studies, the key to successful improvements in Preparer utilization is the

ability to guarantee a sufficient deposit of unprepared freight on the shipping platforms so that work is constantly available. This requires that order picking be done far enough in advance of preparation or that pick times be reduced so that this condition can be assured. A current project concerning warehouse storage slot rearrangements with consequent reductions is pick times will impact this problem. Other alternatives can also be considered. A staggered work shift with order picking beginning before the start of the Preparers' work shift would be one alternative. A redeployed operation with equal Forklift complements over each shift and a heavier second shift complement of Preparers may be used to the same advantage. With the advent of improvement and simplifications in Preparer work activities, these systems will be more easily evaluated.

V. PREPARER SET-UP TIME

Category 1, Preparer set-up time, showed a surprisingly high 23 percent total work effort. This activity includes order review, label retrieval, stencil cutting and the application of stencils to fill-in product labels. The current methods present the following problems which account for the five men allocated for this activity:

1. Active labels are stored in duplicate in two physically separated shipping sections with a master file in one of these sections. With the inventory control problems brought about from this arrangement, label searches and inventory depletions cause work interruptions and long walks to the master file for label replenishment.
2. Because product grades must be stencilled on the many fill-in product labels which are drawn during the course of the day, stencil cutting on conventional "chop-out" type machines is a continuous and time consuming process. Application of these stencils to each label is also time consuming.
3. The whole situation of Preparers having to move throughout their work area to the label cabinets and stencil machines in readying themselves for the actual container preparation task makes for a poor

work system and introduces too much distraction from normal productive work.

It was an early conclusion that this situation could easily be remedied by consolidating the activities of category 1, which includes order review, label retrieval, stencil cutting and stencilling fill-in product labels, into one centralized work station situated in the shipping office. This station, which would include facilities for rapid retrieval of labels, stencil cutting and stencil application to labels, would allow orders to impact the shipping platforms in packaged work sets, with the only requirements left for normal preparation to be the application of labels and stencils to the containers. Not only would the manpower requirements for this function be reduced, but the need to duplicate label files, stencil cutters and equipment in both shipping sections could be avoided.

VI. LABEL RETRIEVAL

Several alternate methods of label retrieval were evaluated. With over two hundred different labels currently in use, in all shapes and sizes, ready access to any label called for can be a problem. The filing space to house even a working stock of each label in the Shipping Office is extensive. This suggests the use of some kind of automatic filing system which will not only reduce retrieval times, but most efficiently utilize limited floor space.

A power filing unit is one solution to the problem. This system incorporates a series of revolving file cradles, with each containing a number of compartments for housing the different labels. Access to any label is made simply by keying in the appropriate cradle number (via a push button keyboard) which brings the cradle containing that label to the front of the file. Selection of the right label is then narrowed to an average of eight to ten compartments within the cradle. Because this unit is built close to ceiling height, floor space utilization is increased 60 percent over conventional files. All label retrieval could be done without the clerk having to leave his seat. This system could be purchased for approximately $6,500 (with a capacity to hold about 2,500 of each

label).

A more sophisticated retrieval system has also been considered. This system features the automatic transfer of storage bins from an enclosed structure to the work-face of the operator's desk. Commands are also entered via a keyboard as with the power file, but the bin that's delivered contains an average of only two different labels from which the desired label is drawn. This system, with a capacity large enough to contain a working file of 2,500 of each label, would cost around $15,000.

With acceptance of a pending proposal to print product labels in-plant, virtually all active labels in stock could be held in either of these systems and inventory control problems could be reduced even further.

VII. STENCILLING OF PRODUCT LABELS

It is the current practice of cutting an oilboard stencil each time a certain product grade is called for on a fill-in type label. The most obvious alternative to this is the maintenance of a permant stencil or rubber stamp file so that the repetitious cutting of like product grade stencils doesn't have to go on day after day. However with over five hundred possible grades, search and retrieval times from a stencil or stamp file could well exceed stencil cutting times, expecially on the shipping floor. Confusion and delay could also result when more than one person needed the same grade or if stencils or stamps were misplaced.

With the proposition of moving this function into the Shipping Office with the centralized label station, the following system becomes available:

1. A paper stencil is cut on a special 3/16" typewriter. Stencils are supplied in continuous-feed rolls.
2. The stencil is attached to a self-inking handprinter.
3. Labels are marked (and counted) in quick succession.

This method of marking labels would result in time savings of about 45 seconds in stencil cutting and 3 seconds in stencil application per label. Money would also be saved in supplies costs.

VIII. STENCIL CUTTING

After replacement of product grade stencil cutting with the typewriter soft stencil system, about 70 percent of the current stencil demand will be eliminated. The remaining stencils will be container-applied stencils made up of address, customer requested codes and export marks.

Address stencils are generally cut when there are twenty pieces or more on the order. Otherwise the address comes out in the form of a label run off on the multilith in the office. Truckload quantities of freight going to one customer don't usually require any address markings at all.

The question of whether to cut a stencil or run labels for addresses on an order depends on the trade-offs between stencil and label preparation times and the actual floor application times for each of these. Under the present system a three line address stencil takes about 1½ minutes to cut and 3 seconds per container to apply. Labels average about 20 seconds per application. Excluding multilith run time for label preparation, an order of six pieces or more would call for stencilling rather than labelling.

Customer requested codes, usually of one line, and

export marks, of five lines, comprise the rest of the required stencils. Codes are required on about fifty line items per day and export marks on about fifteen orders.

The possibility of using a soft stencil system on these remaining stencils is also appealing. The Rohm and Haas plant in Bristol, Pennsylvania has already replaced conventional oilboard cutting and roll-ink stencil application in their production buildings with a soft stencil and handprinter system. They report complete satisfaction. The handprinter can cut application times from three seconds under the conventional methods to around one second.

The choice of a soft stencil cutter is between a manual dial-operated type (similar in operation and speed to conventional "chop-out" oilboard cutters) and an electric keyboard console unit. The former, used at Bristol, is priced in the $350 to $400 price range, while the automatic, which is about three times as fast, cost close to $3,800. While $3,800 may seem a high price for a stencil cutter, the extra speed and convenience may show a favorable return in this operation.

IX. STENCIL AND LABEL APPLICATION TO CONTAINERS

The work sampling revealed that over seven men out of the total complement were dedicated to these two activities. Label application makes up about 80 percent of this, but unfortunately, attempts were unseccessful in finding a better method of gluing or applying the many labels used each day. A label gluer was tested and may have shown promise, but the labels in current use tended to curl after they were run through this apparatus. This made the application of the label very difficult. For the time being, it seems that the glue pot and brush will remain in this operation.

Stencils are applied to containers at a rate of at least five times that of labels. For this reason, the key to time savings in this category is the replacement of labelling with stencilling wherever possible. Address labels are the prime candidate for replacement in this operation.

Address labelling makes up about 20 percent of the total container labelling and stencilling effort. In terms of manpower requirements, this translates to about 1.50 men (.20 X 7.30 men) from TABLE 1. By substituting conventional stencilling for labelling in this activity, only 20 percent of this manpower, or .30 men, would be

required. Finally, if the handprinter stencilling system is used, which is rated at twice the speed of conventional stencilling, only .15 men would be necessary.

Other stencilling in this category makes up another 20 percent of the total. This again translates to 1.50 men meaning the use of a handprinter can reduce this to .75 men.

The above has a potential for savings of approximately two people.

X. STEEL DRUM RECONDITIONING

It had always been thought that steel drum reconditioning was the predominate factor in the total preparation of containers. The sampling indicated, however, that only between three and five men out of the total twenty-seven were involved in this task on a typical day (at the time the study was made). The apparent drop in its incidence has been attributed to recent lower inventory levels and higher turnover rates which result in less outside drum exposure and consequently, less required reconditioning.

The original plan of action for this area was to determine first what the appearance standards for shippable containers should be for this plant in comparison to other plant locations and then to evaluate alternatives to present reconditioning methods. On the agenda was an evaluation of drum covers, automatic high-pressure washing, insulating pallets, plastic drums, and weather resistant paints. However, before any progress was made on these evaluations, plant management decided to relax appearance standards to the point at which virtually all reconditioning will soon be eliminated.

XI. REVISED SYSTEM DESIGN

The revised system if implemented as successfully as expected would result in Preparer reductions of seven men. The addition of one person per shift would be required at the label station in the Shipping Office (see Appendix C). The work flow would be handled in the following manner (also shown in FIGURE 4):

1. The Shipping Order Scheduler would receive and scan orders as he presently does, but he would also cut all required stencils (except product grade). These would average about one-hundred fifty addresses, fifty customer requested codes and fifteen export marks per day. Using an electric soft stencil cutter, this would take about one hour per shift over the course of the day. The scheduler's work load is erratic and slack periods would easily allow this extra task to be fitted into his schedule.
2. Stencils would be clipped to the order where applicable and then the order or order set would await scheduling.
3. After the trucks are scheduled, the orders and stencils would be passed on to the label retrieval station.

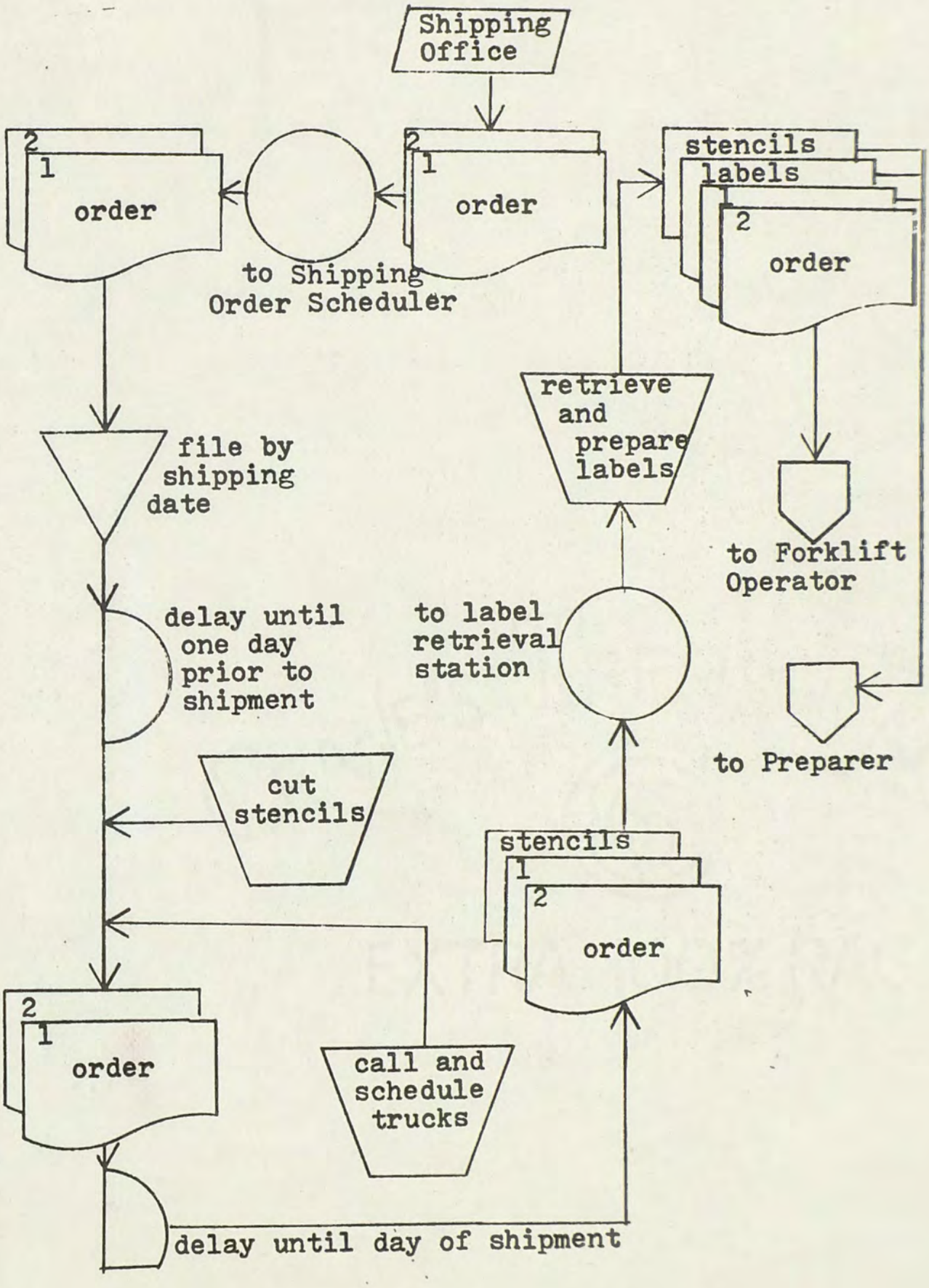
4. The label clerk would then draw the required labels, cut and stencil product grades if required, and clip the labels onto the appropriate yellow prep copy of the order. Order sets would then be ready to go to the floor.

5. As order sets reach the floor, work can be assigned to each Preparer in the form of a packaged work set. The cart from which each man is operating will contain all necessary working supplies including two handprinters, one holding black ink and the other with white ink. All stencilling will be done with these handprinters. Without the distractions of label retrieval, stencil cutting and label stencilling, the Preparer will be able to work continuously from his cart in all normal preparation.

Aside from labor savings, the proposed system will offer other advantages to Physical Shipping. Because work will be distributed to the Preparers in packaged work sets, individually when possible, the Dock Foreman will be able to readily assess the amount of work he's assigning each Preparer by the size and composition of each work set. Because the men will be working in a more constrained fashion--within the confines of the aisles of freight to which they're assigned--more control over individual performance can be exercised and unauthorized breaking and idleness will be more easily identified.

The reduced complements will also give each Dock Foreman fewer men to direct and more time for other matters.

FIGURE 4. Revised Work Flow



XII. SUMMARY AND CONCLUSION

This report has outlined the work sampling and methods improvements study of Shipment Preparer activities in the Shipping Center. A revised system is recommended which could mean labor savings of approximately five people as well as additional operational improvements. With average dock labor costing $14,000 annually, this represents an annual savings of $70,000.

Basically, the system would operate with the following changes:

1. Label stocks would be consolidated and moved into an automatic filing and retrieval system located within the Shipping Office. Label retrieval duties would then be removed from the Preparer complement and shifted to Shipping Office personnel.
2. Methods of stencil cutting and stencil application would be changed. A soft stencil system with handprinters would replace conventional oilboard stencilling. Address labels would be replaced by stencils for the quicker handprinter application. All stencil cutting and label marking would be completed in the Shipping Office.

The overall result of this system will be the ability to present the Shipment Preparer with a complete

packaged work set of labels and stencils from which he can operate directly.

The analysis indicates that Preparer complement reductions will total five men by virtue of a label retrieval and stencilling work station and two men because of improved stencilling methods. The additional Shipping Office manpower requirements are estimated at two people.

The initial investment cost for equipment for this system is extimated at less than $28,000, most of which is for the label retrieval equipment. This project quite obviously meets the company's 20 percent minimum after tax return on investment requirement.

Full implementation would be tentatively scheduled in about three months depending on equipment availability. At that time, the Preparer complement would be reduced by three men, the balance being taken out gradually as the equipment and system is placed on stream. With five men already earmarked for transfer due to the pending termination of most steel drum reconditioning, the present complement of twenty-seven Preparers (two of which are actually classified as Car Bracers) would be reduced to fifteen. Further improvements in manpower utilization and productivity could conceivably bring this number down to somewhere around thirteen people.

APPENDIX A. WORK SAMPLING METHOD

The work sampling was conducted over a period of nineteen working days from March 11 to April 4. Prior to this, the Preparers' shipping platform duties were divided into the following four general observation categories:

1. Set-up--order review, label retrieval, stencil cutting, stencilling of product grades on fill-in product labels
2. Application of labels and stencils to containers
3. Steel drum reconditioning
4. a) Loading freight
   b) Palletizing
   c) Other productive work

This categorization was constructed in such a way as to align itself with a previously conceived outline of potential methods improvements areas. The objective of the work sampling was to determine what percentages of the Preparers' productive time, and consequently what proportion of the manpower complement, was devoted to each of the activity areas. Ordinarily, the sampling of an operation such as this would have dictated a more precise, detailed breakdown of categories rather than the broad divisions of activity chosen. This approach was governed

by the following logic:

1. Only one observer was available to make the many required observation trips accross a rather expansive shipping platform. This made quick visual recognition and identification of individual Preparer activity imperative.
2. It was planned to keep the duration of the sampling as short as possible. Since the number of samples required for acceptable accuracy increases with the number of observed categories, the limited grouping chosen was conducive to this strategy.
3. The eventual application of the results of the work sampling to the pending methods improvement program was known and it was realized that the broad categories chosen would suffice. The groups of activity comprising category 1 were lumped together because it was felt that the improved system would necessarily embody these activities into one consolidated function.

In category 2, the relationship between stencilling times and label application times was already known and it wasn't felt necessary to break these out. Category 4(c), which included any other productive work not previously defined, turned out to show a favorably low percentage of the total activity, indicating a good selection and adequate coverage of the other categories.

The work sampling was carried out in the normal manner and under the following conditions:

1. The random sampling involved the recording of productive Preparer platform activities only. Preparer activities in areas other than the normal preparation zones were omitted (with the exception of Preparer transit between the two shipping zones and occasional container preparation in the warehouse aisles). The effect of this extraneous activity was rather minimal during the sample period and was excluded from the analysis.
2. No attempt was made to distinguish legitimate idle time (through lack of available work) from unauthorized idleness.
3. Random observation trips scheduled at times close to break periods when productivity is typically low, or at other times of low utilization, were postponed and rescheduled.

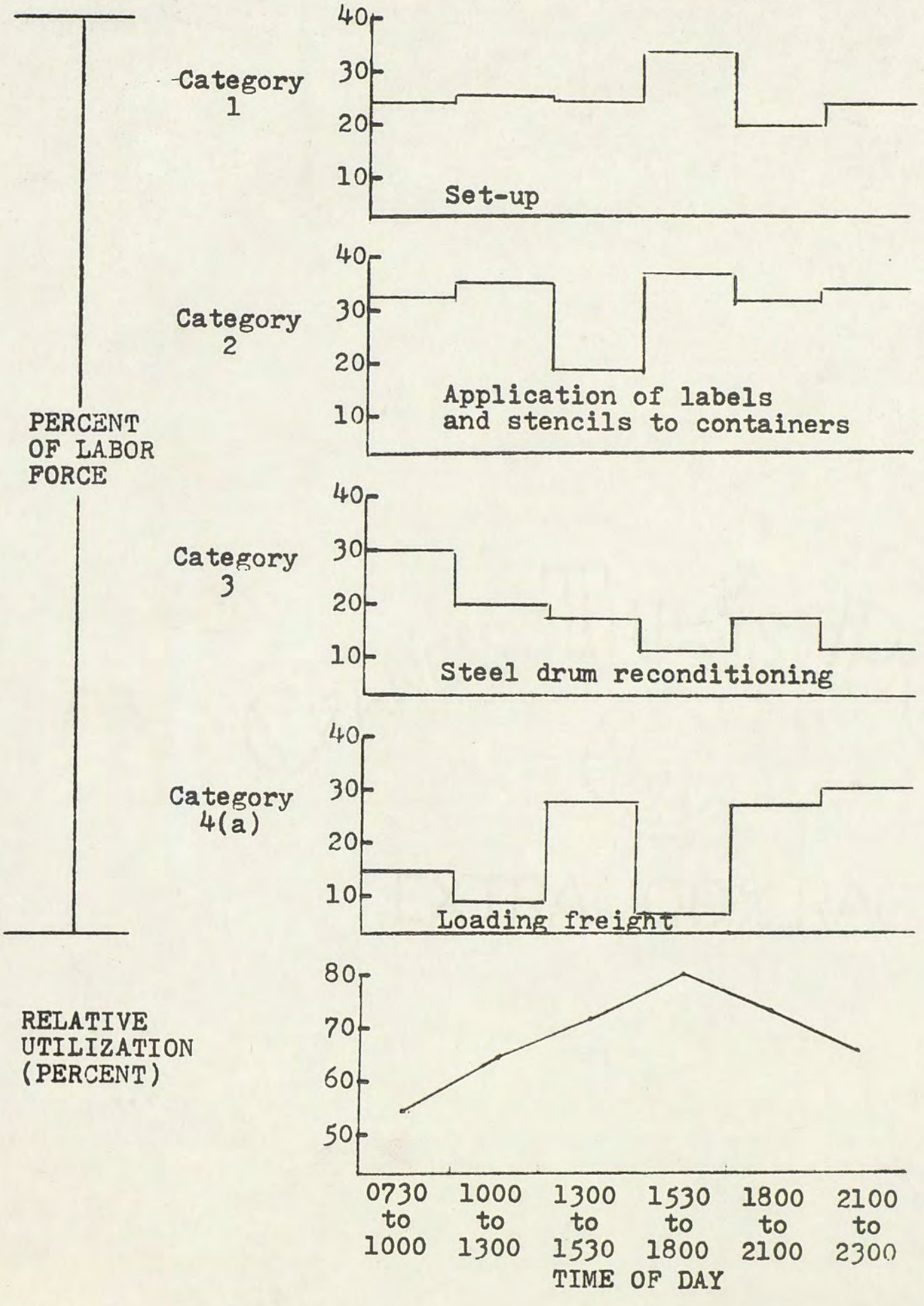
The conditions described above seem somewhat restrictive but, again, had to be imposed to reduce the time and manpower constraints of the sampling. A major sacrifice here is in the quantitive Preparer utilization data that could have been extracted had strict sampling procedures been adhered to. Some utilization information was derived and is presented in Appendix B with the understanding that the third condition above will cause a bias in the direction

of higher utilization than is actually the case.

APPENDIX B. MANPOWER DEPLOYMENT AND UTILIZATION

FIGURE 5 shows the relationship between the time of day and the percent of the labor force engaged in each category activity. (Category 4(b), palletizing and category 4(c), any other productive work, were excluded from this analysis.) It also shows the relative utilization of manpower vs. time of day. This utilization data is termed "relative" because of the nature in which the sampling observations were made which caused a bias in favor of higher utilization than is actually the case.

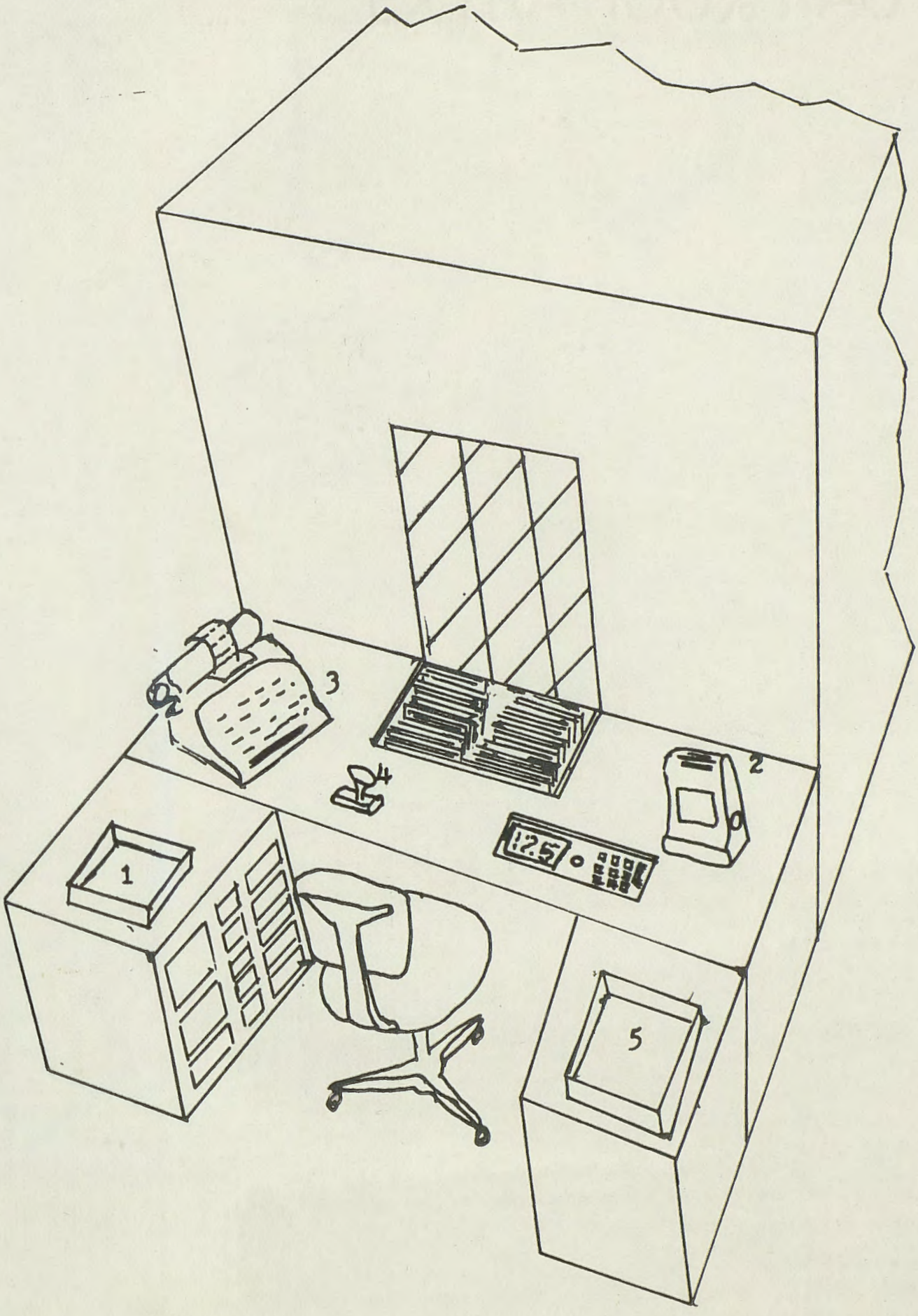
FIGURE 5. Manpower Deployment and Utilization



APPENDIX C. LABEL RETRIEVAL WORK STATION

The label retrieval work station is shown pictorially in FIGURE 6. Major component parts of this system are a basket (1) for inbound orders, a microfilm viewer (2) holding product code-label number references, a special typewriter (3) with ¼ inch characters for cutting rolled paper stencils, a handprinter (4) with self-contained ink supply and quick-change stencil clamps and a basket (5) for outbound order sets.

FIGURE 6. Work Station Pictorial



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